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Navy Researchers Work to Incorporate Antibiotics into Cranial Implants

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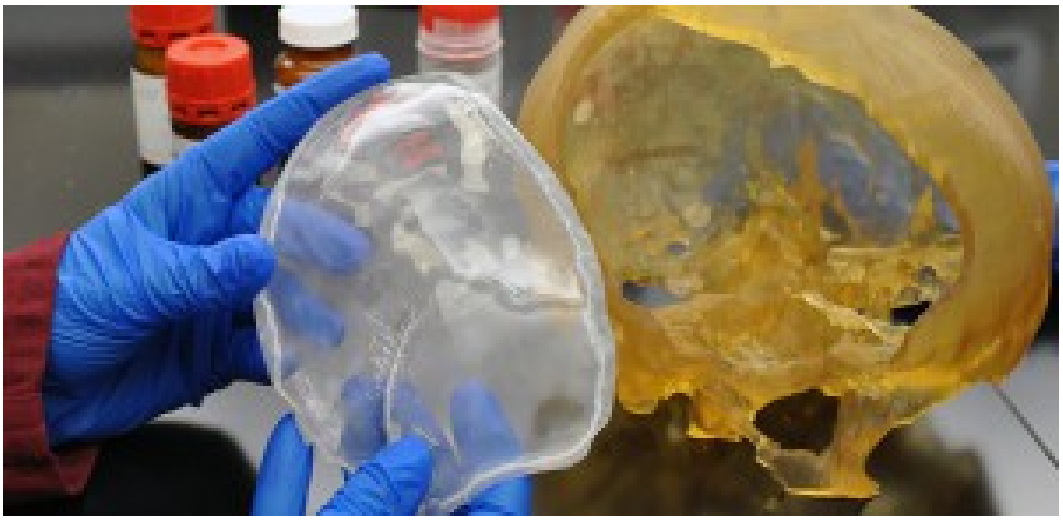
By Capt. Jonathan M. Stahl, DC, Naval Medical Research Unit-San Antonio



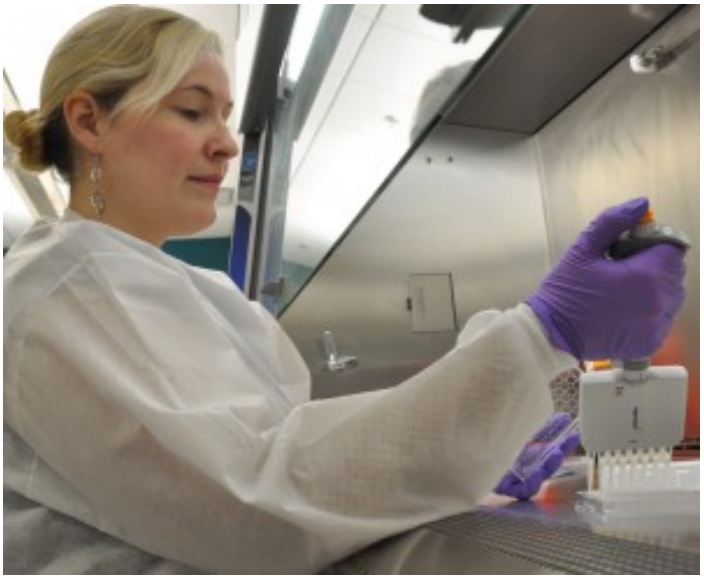
Polymethyl methacrylate (PMMA) is a transparent and rigid plastic used for cranial implants and is custom molded to cover large areas of cranial destruction. In this image an implant has been fabricated to fit a large defect as seen in the three-dimensional stereolithography model. NAMRU-SA's goal is to incorporate antibiotics directly into an implant to reduce infection rates.

(Photo by Flisa Stevenson, NAMRU-SA Public Affairs)

The role of Navy dental research has expanded over the years to focus on addressing dental and biomedical problems that will increase operational readiness as well as address emergent dental and craniofacial issues. Currently, the Craniofacial Health and Restorative Medicine Directorate at Naval Medical Research Unit - San Antonio (NAMRU San Antonio) remains dedicated to developing novel treatment approaches that will keep Sailors and Marines fit to fight.

The military has an excellent record of preventing and controlling infections, but multiple bacterial infections and antibiotic resistance remain a problem. The infection rate for cranial reconstruction surgeries where a cranial plate is implanted after traumatic injuries to the head is up to 15%. In severe cases of infections, warfighters often require repeated cranial reconstruction surgery, which can cause psychological stress, complicate healing, decrease deployability time, and increase costs to the Navy and Marine Corps.

Polymethyl methacrylate (PMMA) is the most widely used cranioplasty material. This synthetic polymer can be easily formed into shapes to replace bony defects created from traumatic injuries and has excellent physical properties. Past research efforts have shown that antibiotics can be incorporated into PMMA when implants are created and the implant will potentially serve as a localized delivery system of antibiotics to prevent the occurrence of post-surgical infections.



NAMRU-SA Microbiologist, Tamara Hess, MS., investigates the activity of antibiotics eluted from PMMA against military-relevant pathogenic bacteria common to post-surgical cranial infections. (Photo by Flisa Stevenson, NAMRU-SA Public Affairs)

One goal of NAMRU-SA's current research efforts is to determine the clinical suitability of antibiotic impregnated cranial implants by evaluating their antimicrobial and mechanical properties. In our current study, the antimicrobial effectiveness of varying classes of antibiotics are being evaluated against microbial pathogens including multi-drug resistant pathogenic bacteria such methicillin resistant *Streptococcus aureus*, good candidates will then be incorporated into PMMA for characterization.

NAMRU-SA Material Science Engineer and Postdoctoral Fellow, Shehreen Dheda, Ph.D. (right) and Microbiologist, Tamara Hess, MS. (left), evaluate candidate antibiotics to incorporate into PMMA implants. (Photo by Flisa Stevenson, NAMRU-SA Public Affairs)

Our findings thus far have demonstrated that some antibiotics incorporated into PMMA even in relatively small quantities weaken the physical properties of the final implant to the point where it is not suitable for clinical usage. Other antibiotics while not degrading the structural properties of the implant are themselves structurally degraded by the heat from the chemical reaction that is generated in PMMA implant fabrication.

The eventual goal is to find formulations of PMMA containing antibiotics that fulfills both ideal antimicrobial and mechanical properties. This will ultimately reduce infection rates and greatly enhance the quality of life of warfighters which is the mission and passion of the craniofacial research staff at NAMRU-SA.

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